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N.J. 08405

Statistics on Aircraft Gas Turbine Engine Rotor Failures that Occurred in U. S. Commercial Aviation During 1984

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June 1989

Final Report

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U.S. Department of Transportation
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16. Abstract

This report presents statistical information relating to gas turbine engine rotor failures which occurred during 1984 in commercial aviation service use. Two hundred and six failures occurred in 1984. Rotor fragments were generated in 114 of the failures and, of these, 18 were uncontained. The predominant failure involved blade fragments, 90.3 percent of which were contained. Seven disk failures occurred and all were uncontained. Seventy percent of the 206 failures occurred during the takeoff and climb stages of flight.

This service data analysis is prepared on a calendar year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

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EXECUTIVE SUMMARY

This service data analysis is prepared on a calendar basis and published annually. The data support flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses. The following statistics are based on gas turbine engine rotor failures that have occurred in United States commercial aviation during 1984.

Two hundred and six rotor failures were reported in 1984. These failures accounted for approximately 12 percent of the 1657 shutdowns experienced by the United States commercial fleet. Rotor fragments were generated in 114 of the failures and, of these, 18 were uncontained. This represents an uncontained failure rate of 1.8 per million gas turbine engine powered aircraft flight hours, or 0.7 per million engine operating hours. Approximately 10.2 million and 24.7 million aircraft flight and engine operating hours, respectively, were logged in 1984.

Turbine rotor fragment-producing failures were approximately two times greater than that of the compressor rotor fragment-producing failures (79 and 32 respectively, of the total). Fan rotor failures accounted for three of the fragment-producing failures experienced.

Blade fragments were generated in 103 of the rotor failures; 10 of these were uncontained. The remaining eleven fragment-generating failures were produced by disk, rim, and seal.

Of the 115 known causes of failures (because of the high percentage of unknown causes of rotor failures, the percentages were based on the total number of known causes), the causal factors were (1) foreign object damage--48 (41.7 percent); (2) secondary causes--35 (30.4 percent); and (3) design and life prediction problems--32 (27.8 percent). One hundred and forty-five (71.4 percent) of the 206 rotor failures occurred during the takeoff and climb stages of flight. Ninety (78.9 percent) of the 114 rotor fragment-producing failures and 14 (77.8 percent) of the 18 uncontained rotor failures occurred during these same stages of flight.

The incidence of engine rotor failures producing fragments has increased 18.7 percent from 1983 (96 in 1983 and 114 in 1984). The uncontained engine rotor failures has increased 100 percent in 1984 (9 in 1983 and 18 in 1984). The 10-year (1975 through 1984) average of uncontained engine rotor failures has increased to 15.2.

INTRODUCTION

This report is sponsored and co-authored by the Federal Aviation Administration (FAA) Technical Center, located at the Atlantic City International Airport, New Jersey.

This service data analysis is published yearly. The data support flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

The intent and purpose of this report is to present data as objectively as possible on rotor failure occurrences in United States commercial aviation. Presented in this report are statistics on gas turbine engine utilization and failures that have occurred in U.S. commercial aviation during 1984. These statistics are based on service data compiled by the FAA Flight Standards District Office. The National Safety Data Branch of the FAA Aviation Standards National Field Office disseminates this information in a service difficulty data base and the Air Carrier Aircraft Utilization and Propulsion Reliability Report. The FAA service data base contains only a fraction of the actual commercial helicopter fleet operating statistics. The number of turboshaft engines in use with the corresponding engine flight hours given herein are estimates derived primarily from statistics published by the Helicopter Association International in their helicoper annuals. The compiled data were analyzed to establish:

1. The incidence of rotor failures and the incidence of contained and uncontained rotor fragments (an uncontained rotor failure is defined as a rotor failure that produces fragments which penetrate and escape the confines of the engine casing).

2. The distribution of rotor failures with respect to engine rotor components, i.e., fan, compressor or turbine rotors and their rotating attachments or appendages such as spacers and seals.

3. The number of rotor failures according to engine model and engine fleet hours.

4. The type of rotor fragment (disk, rim, or blade) typically generated at failure.

5. The cause of failure.

6. The flight conditions at the time of failure.

7. Engine failure rate according to engine fleet hours.

RESULTS

The data used for analysis are contained in appendix A. The results of these analyses are shown in figures 1 through 7 and tables 1 and 2.

Figure 1 shows that 206 rotor failures occurred in 1984. These rotor failures accounted for approximately 12.4 percent of the 1657 shutdowns experienced by the gas turbine powered U.S. commercial aircraft fleet during 1984. Rotor fragments were generated in 114 of the failures experienced and, of these, 18 (15.8 percent of the fragment-producing failures) were uncontained. This represents an uncontained failure rate of 1.8 per million gas turbine engine powered aircraft flight hours, or 0.7 per million engine operating hours.

Approximately 10.1 million and 24.6 million aircraft flight and engine operating hours, respectively, were logged by the U.S. commercial aviation fleet in 1984. Gas turbine engine fleet operating hours relative to the number of rotor failures and type of engines in use are shown in figure 2.

Figure 3 shows the distribution of rotor failures that produced fragments according to the engine component involved (fan, compressor, turbine), the type of fragments that were generated, and the percentage of uncontained failures according to the type of fragment generated. These data indicate that:

1. The incidence of turbine rotor fragment-producing failures was approximately two times greater than that of the compressor rotor fragment-producing failures; these corresponded to 78 (68.4 percent) and 33 (28.9 percent), respectively, of the total number of fragment-producing failures. Fan rotor failures accounted for three (2.6 percent) of the fragment-producing failures experienced.

2. Blade fragments were generated in 103 (90.3 percent) of the rotor failures; 10 (8.8 percent) of these were uncontained. The remaining 11 (9.6 percent) rotor fragment failures were produced by disk, rim, and seal. All of the seven disk failures were uncontained, one rim failure was contained, and one of the three seal failures was uncontained.

Figure 4 shows the rotor failure distribution among the engine models that were affected and the total number of the models in use.

Table 1 contains a compilation of engine failure rates per million engine flight hours according to engine model, engine type, and containment condition. The engine failure rates per million flight hours by engine type are turbofan/turbojet--8.5, turboprop--11.1, and turboshaft--2.0. Uncontained engine failure rates per million flight hours by engine type were turbofan/turbojet--0.7, turboprop--0.8, and turboshaft--1.0.

Figure 5 shows what caused the rotor failures to occur. Of the 115 known causes of failure (because of the high percentage of unknown causes of rotor failure, the percentages were based on the total number of known causes), the causal factors were (1) foreign object damage--48 (41.7 percent); (2) secondary causes--35 (30.4 percent); and (3) design and life prediction problems--32 (27.8 percent).

Figure 6 indicates the flight conditions that existed when the various rotor failures occurred. One hundred and forty-five (70.4 percent) of the 206 rotor failures occurred during the takeoff and climb stages of flight. Ninety (78.9 percent) of the rotor fragment-producing failures and 14 (77.8 percent) of the uncontained rotor failures occurred during these same stages of flight. The highest number of uncontained rotor failures, 11 (61.1 percent), happened during takeoff.

Table 2 is a cumulative tabulation that describes the distribution of uncontained rotor failures according to fragment type, engine component involved, cause category, and flight condition (takeoff and climb are defined as "high power," all other conditions are defined as "low power") for the years 1976 through 1984. This table is expanded yearly to include all subsequent uncontained rotor failures. These data indicate that for "secondary causes" the number of uncontained failures was approximately six times greater at "high" power than "low" power (namely 30 and 5). For "design and life prediction problems" the number of "high" power uncontained failures was three times greater than "low" power (namely 24 and 8); and for "foreign object damage" the number of uncontained failures was seven times greater at "high" power than "low" power (namely 7 and 1). This tabulation also indicates that of the 138 total uncontained incidences, blade failures accounted for 68.1 percent; disk failures, 20.3 percent; rim failures, 5.1 percent; and seal/spacer failures, 6.5 percent.

Figure 7 shows the annual incidence of uncontained rotor failures in commercial aviation for the years 1962 through 1984. During 1984, the incidence of uncontained rotor failures increased by nine over the previous year, 1983. Over the past 10 years, 1975 through 1984, an average of 15.2 uncontained rotor failures per year have occurred. During the same time period, the rate of uncontained rotor failures has remained relatively constant at an average of approximately one per million engine operating hours.

DISCUSSION AND CONCLUSIONS

The incidence of engine rotor fragment-producing failures has remained relatively constant when compared to 1983 (96 in 1983 and 114 in 1984). The uncontained engine rotor failures has increased 100 percent (18 in 1984 and 9 in 1983). The 10-year (1975 through 1984) average of uncontained engine rotor failures is 15.2.

Of the 18 uncontained events that occurred during 1984, 12 (66.7 percent) involved turbine rotors, 5 (27.8 percent) involved compressor rotors, and 1 (5.6 percent) involved fan rotors.

The predominant cause of failure was attributed to foreign object damage (41.7 percent of the known failures), but no uncontained failure occurred in this category. Secondary causes (30.4 percent of the known failures) and design and life prediction problems (27.8 percent of the known causes) had 4 and 3 uncontained failures, respectively. The causes of the remaining 11 uncontained failures (61.1 percent) are unknown.

Uncontained failures occurred in 3 of the 10 known flight modes; i.e., 11 during takeoff (61.1 percent), 3 during climb (16.7 percent), and 3 in cruise (16.7 percent).

The higher incidences of uncontained rotor failures in calendar years 1967 through 1973 (except for 1968) were probably due to the introduction of newly developed engines entering the commercial aviation fleet, such as the JT9D and CF6 engines.

Structural life prediction and verification is being improved by the increased use of spin chamber testing by government and industry as a means of obtaining failure data for statistically significant samples. In addition, increased development and application of high sensitivity, nondestructive inspection methods should increase the probability of cracks being detected prior to failure. The capability to reduce the causes of failures from secondary effects is also being addressed through technology development programs. However, causes due to foreign object damage still appear to be beyond the control or scope of present technology.

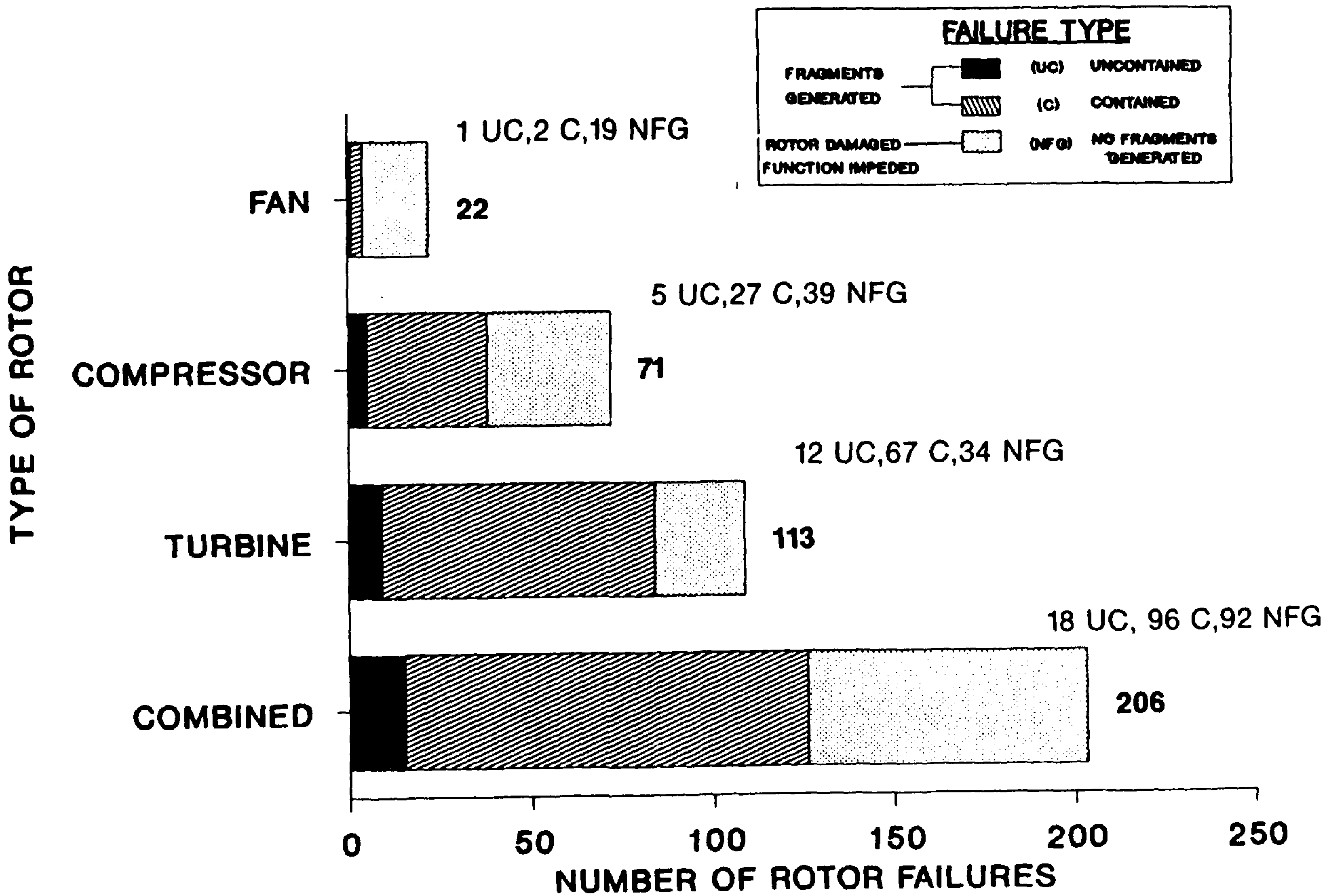


FIGURE 1. INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION - 1984

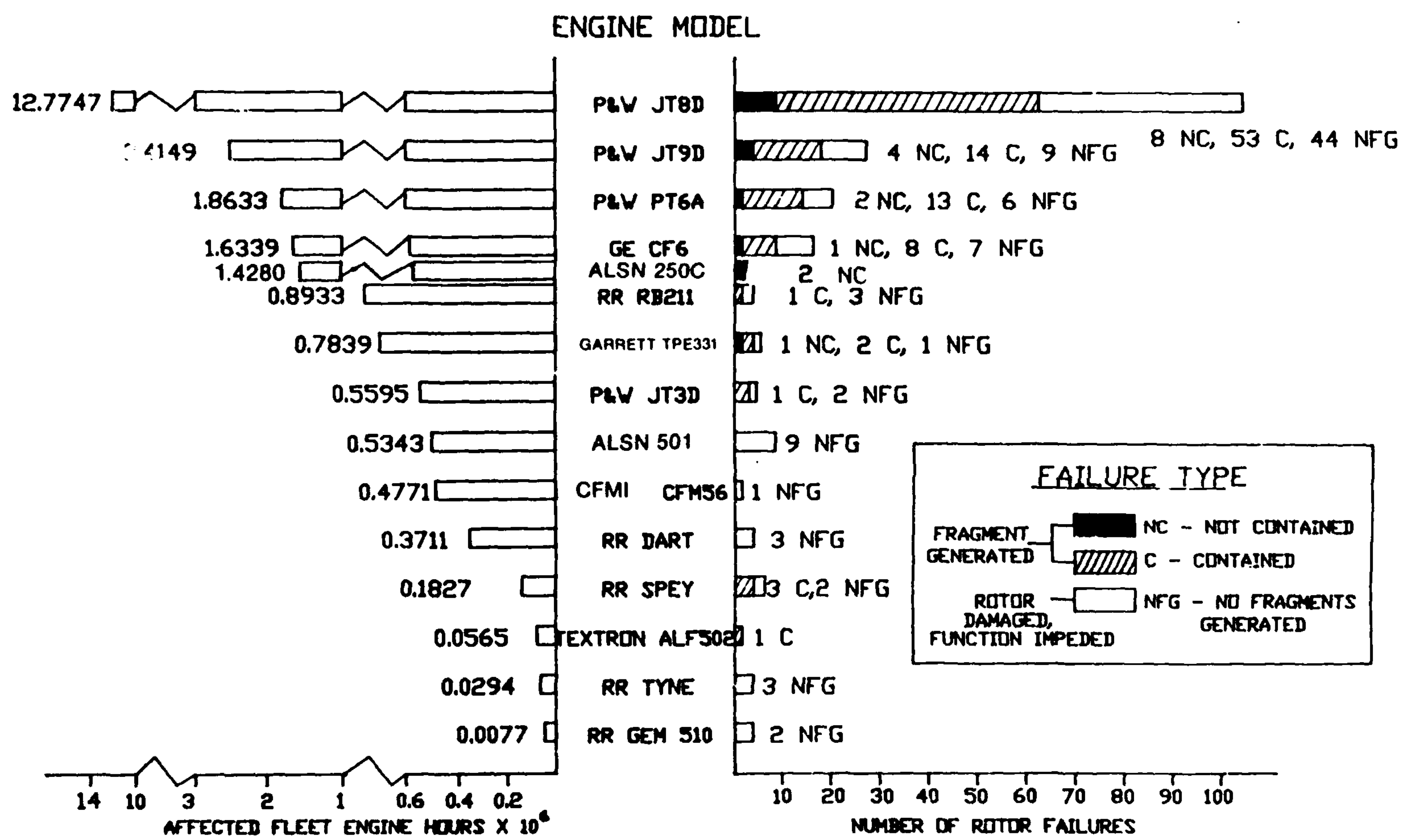


FIGURE 2. INCIDENCE OF ENGINE ROTOR FAILURES IN U.S COMMERCIAL AVIATION ACCORDING TO AFFECTED ENGINE MODEL AND ENGINE FLEET HOURS - 1984

ENGINE ROTOR COMPONENTS	TYPE OF FRAGMENT GENERATED									
	DISK		RIM		BLADE		SEAL		TOTAL	
	TF	UCF	TF	UCF	TF	UCF	TF	UCF	TF	UCF
FAN	0	0	0	0	3	1	0	0	3	1
COMPRESSOR	1	1	0	0	30	4	2	0	33	5
TURBINE	6	6	1	0	70	5	1	1	78	12
TOTAL	7	7	1	0	103	10	3	1	114	18

NOTES:

(1) FAILURES THAT PRODUCED FRAGMENTS

TF - TOTAL FAILURES

UCF - UNCONTAINED FAILURES

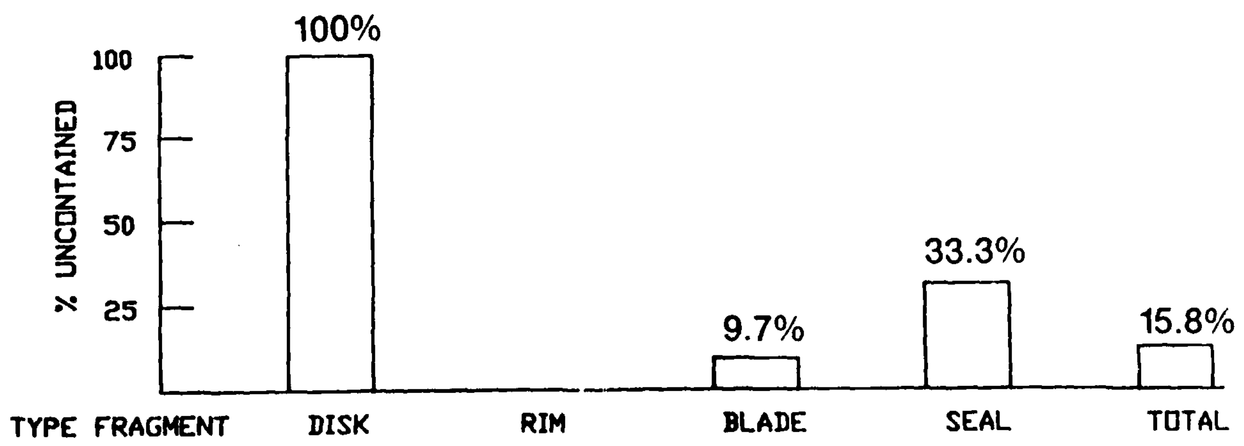
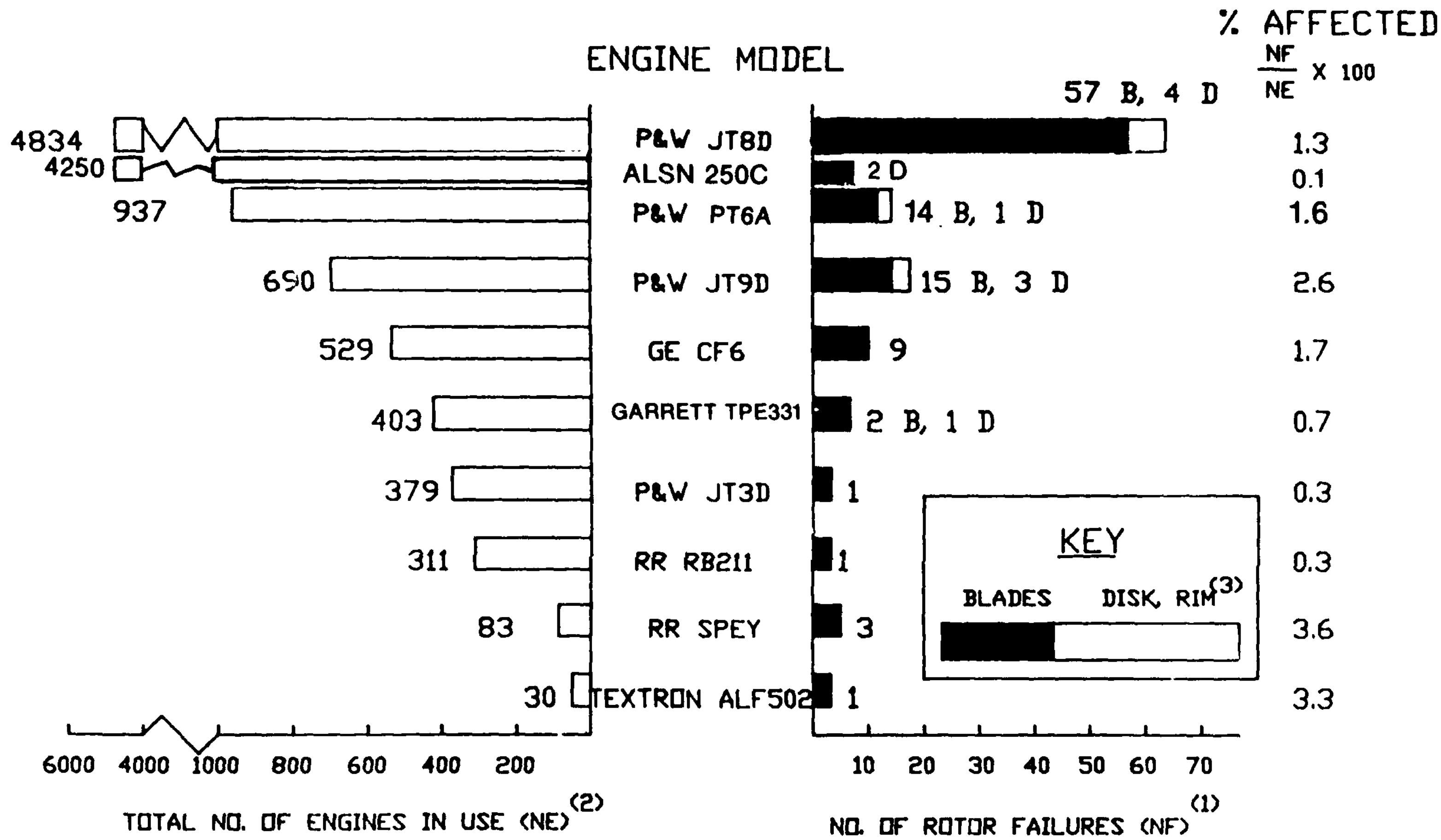


FIGURE 3. COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ROTOR ENGINE FAILURES (FAILURES THAT PRODUCED FRAGMENTS) - 1984



NOTES: (1) FAILURES THAT PRODUCED FRAGMENTS
(2) YEARLY AVG. OF AIRCRAFT IN USE AT END OF EACH MONTH
(3) SEAL/SPACER FAILURES INCLUDED IN DISK/RIM COMPILATION

FIGURE 4. THE INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO ENGINE TYPE AFFECTED - 1984

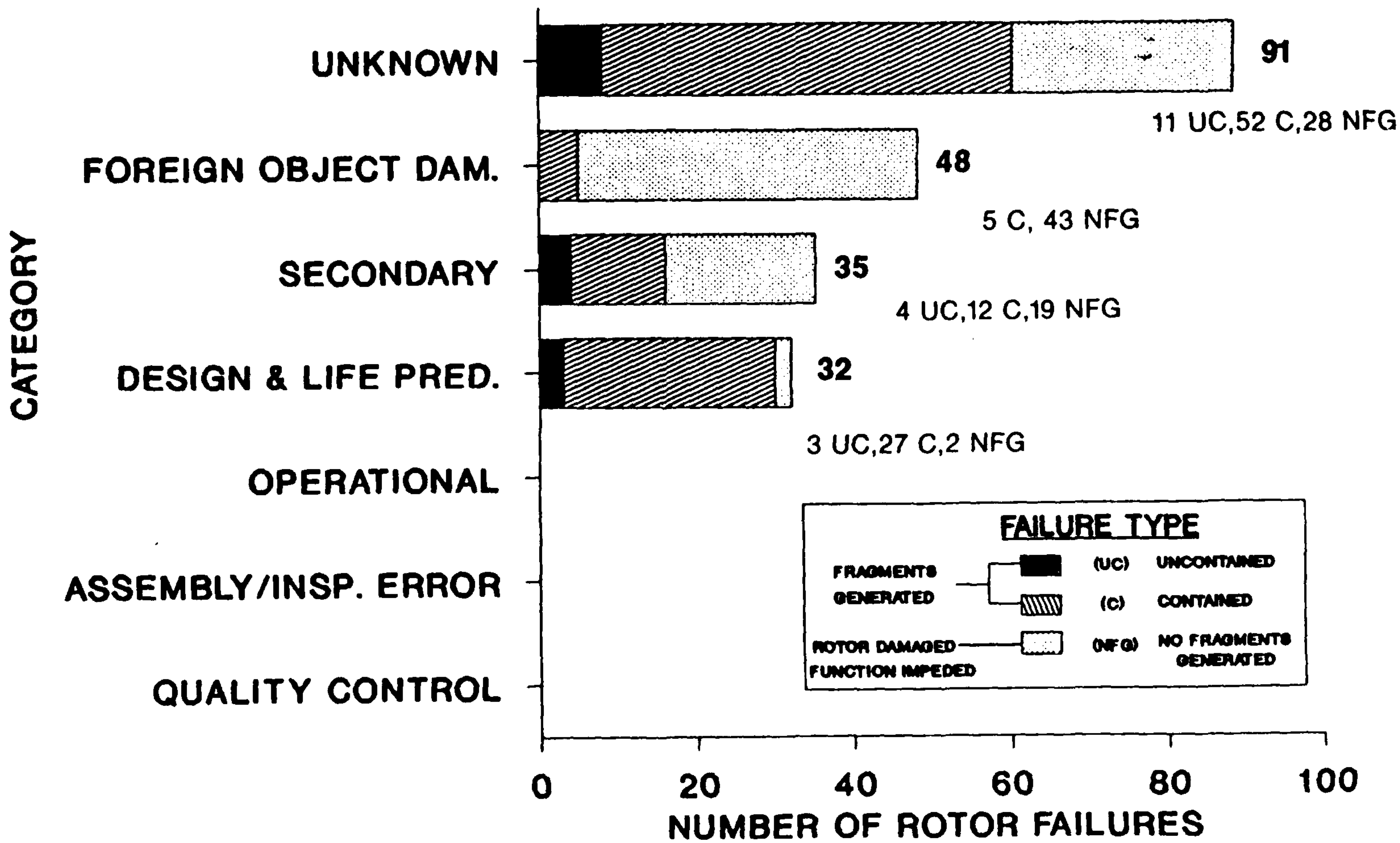


FIGURE 5. ENGINE ROTOR FAILURE CAUSE CATEGORIES - 1984

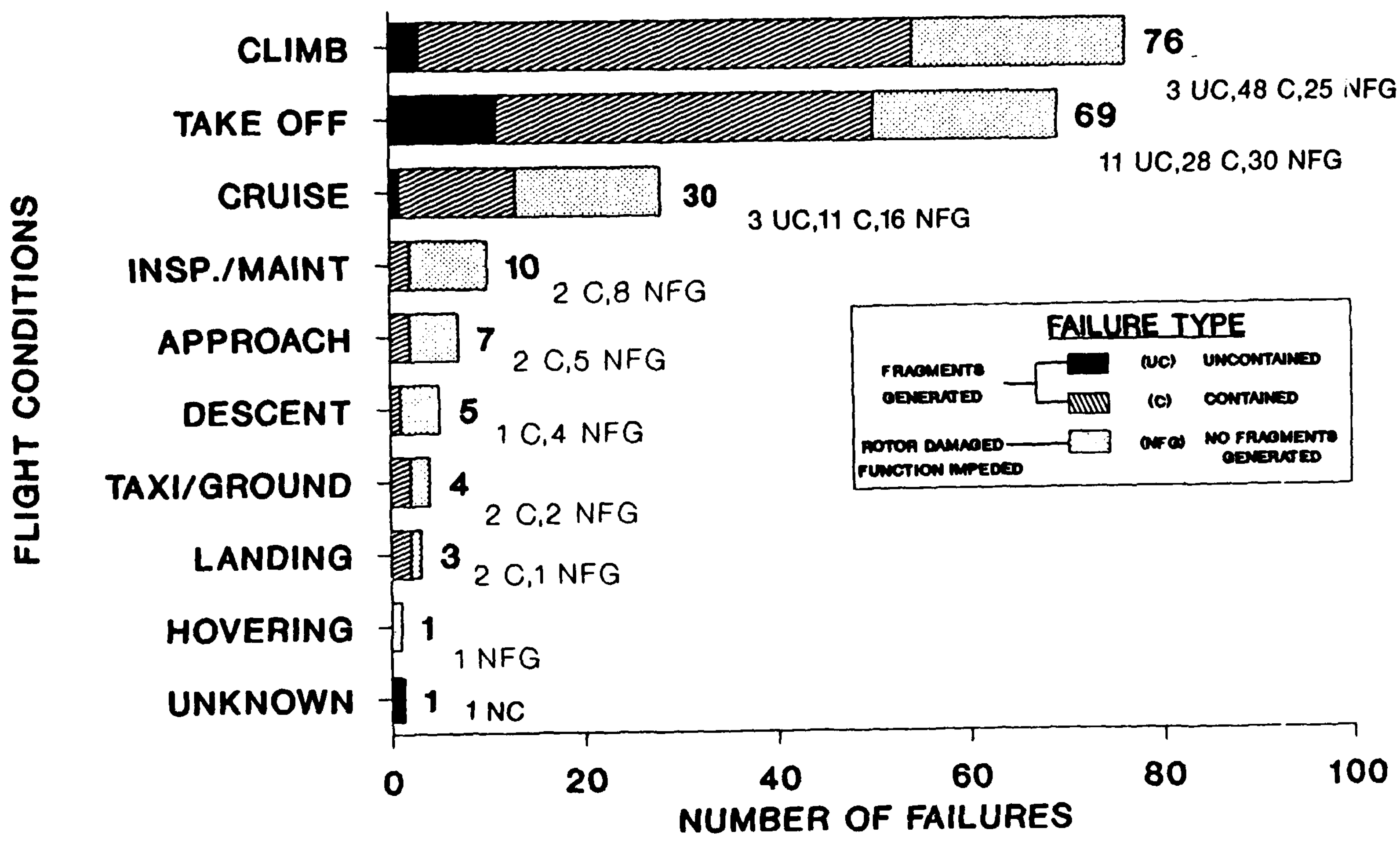


FIGURE 6. FLIGHT CONDITION AT ENGINE ROTOR FAILURE - 1984

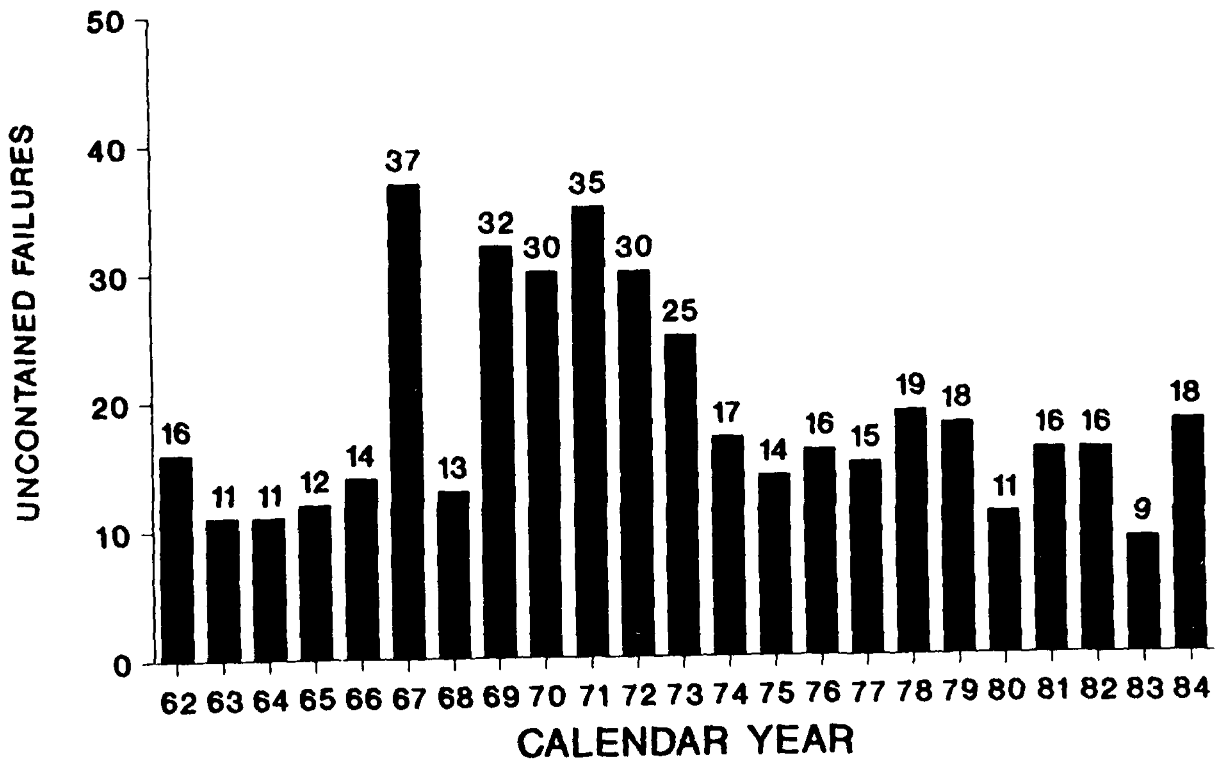


FIGURE 7. THE INCIDENCE OF UNCONTAINED ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION, 1962 through 1984

TABLE 1. GAS TURBINE ENGINE FAILURE RATES ACCORDING TO ENGINE MODEL AND TYPE - 1984

TYPE/ MODEL	AVERAGE NUMBER IN USE	ENGINE FLIGHT HRS.x10^6	NO. OF FAILURES C	NC	N	TOTAL	FAIL.RATES / 10^6 ENGINE FLIGHT HRS. C	NC	N	TOTAL
TURBOFAN/TURBOJET										
JT8D	4834	12.7747	53	8	44	105	4.1	0.6	3.4	8.2
JT3D	379	0.5595	1	0	2	3	1.8	0.0	3.6	5.4
JT9D	690	2.4149	14	4	9	27	5.8	1.7	3.7	11.2
CF6	529	1.6339	8	1	7	16	4.9	0.6	4.3	9.8
RB211	311	0.8933	1	0	3	4	1.1	0.0	3.4	4.5
CF700	15	0.0052	0	0	0	0	0.0	0.0	0.0	0.0
SPEY	83	0.1827	3	0	2	5	16.4	0.0	10.9	27.4
JT15D	3	0.0011	0	0	0	0	0.0	0.0	0.0	0.0
TFE731	9	0.0093	0	0	0	0	0.0	0.0	0.0	0.0
CFM56	229	0.4771	0	0	1	1	0.0	0.0	2.1	2.1
ALF502	30	0.0565	1	0	0	1	17.7	0.0	0.0	17.7
JT4A	41	0.0250	0	0	0	0	0.0	0.0	0.0	0.0
CJ610	2	0.0002	0	0	0	0	0.0	0.0	0.0	0.0
TOTAL	7155	19.0334	81	13	68	162	4.3	0.7	3.6	8.5
TURBOPROP										
PT6A	937	1.8633	13	2	6	21	7.0	1.1	3.2	11.3
ALL501	353	0.5343	0	0	9	9	0.0	0.0	16.8	16.8
TPE331	403	0.7839	2	1	1	4	2.6	1.3	1.3	5.1
DART	260	0.3711	0	0	3	3	0.0	0.0	8.1	8.1
BASTAN	13	0.0227	0	0	0	0	0.0	0.0	0.0	0.0
TYNE	17	0.0294	0	0	3	3	0.0	0.0	102.0	102.0
CT7	6	0.0008	0	0	0	0	0.0	0.0	0.0	0.0
TOTAL	1989	3.6055	15	3	22	40	4.2	0.8	6.1	11.1
TURBOSHAFT										
250C*	4250	1.4280	0	2	0	2	0.0	1.4	0.0	1.4
GEM510	6	0.0077	0	0	2	2	0.0	0.0	259.7	259.7
ALL OTHERS*	1744	0.5860	0	0	0	0	0.0	0.0	0.0	0.0
TOTAL*	6000	2.0217	0	2	2	4	0.0	1.0	1.0	2.0

C = CONTAINED NC = NOT CONTAINED
N = FUNCTION IMPEDED, NO FRAGMENTS GENERATED

*Estimated total number in use and engine flight hours for entire U.S. commercial fleet.

TABLE 2. UNCONTAINED ENGINE ROTOR FAILURE DISTRIBUTIONS ACCORDING TO CAUSE AND FLIGHT CONDITIONS - 1976 THROUGH 1984

TYPE OF FRAGMENT GENERATED		DISK			RIM			BLADE			SEAL				
ENGINE ROTOR COMPONENT		FAN	COMP	TURB	FAN	COMP	TURB	FAN	COMP	TURB	FAN	COMP	TURB	SUB TOT	TOTAL
CAUSE	FLIGHT COND.														
DESIGN/LIFE	HI	0	5	0	0	2	0	8	7	1	0	1	0	24	
PREDICTION	LOW	0	1	3	0	0	0	1	0	3	0	0	0	8	32
PROBLEMS	UNK	0	0	0	0	0	0	0	0	0	0	0	0	0	
SECONDARY	HI	0	1	0	0	0	0	4	4	18	0	0	3	30	
CAUSES	LOW	0	0	0	0	0	0	0	2	3	0	0	0	5	36
	UNK	0	0	0	0	0	0	0	0	1	0	0	0	1	
FOREIGN	HI	1	0	1	0	0	0	5	0	0	0	0	0	7	
OBJECT	LOW	0	0	0	0	0	0	1	0	0	0	0	0	1	10
DAMAGE	UNK	0	0	0	0	0	0	2	0	0	0	0	0	2	
QUALITY	HI	0	1	0	0	0	1	2	0	0	0	0	0	4	
CONTROL	LOW	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	UNK	0	0	0	0	0	0	0	0	0	0	0	0	0	
OPERATIONAL	HI	0	0	0	0	0	0	0	0	0	0	0	0	0	
	LOW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	UNK	0	0	0	0	0	0	0	0	0	0	0	0	0	
ASSEMBLY/	HI	0	0	0	0	0	0	0	0	0	0	0	0	0	
INSP.	LOW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REPORTS	UNK	0	0	0	0	0	0	0	0	0	0	0	0	0	
UNKNOWN	HI	0	1	8	0	3	0	4	8	9	1	2	1	37	
	LOW	1	0	4	0	1	0	0	2	5	0	1	0	14	56
	UNK	0	0	1	0	0	0	1	0	3	0	0	0	5	
SUBTOTAL	HI	1	8	9	0	5	1	23	19	28	1	3	4	102	
	LOW	1	1	7	0	1	0	2	4	11	0	1	0	28	138
	UNK	0	0	1	0	0	0	3	0	4	0	0	0	8	
TOTAL			28			7			94			9		138	138

*Takeoff and climb are defined as "High Power" and all other conditions are defined as "Low Power".

APPENDIX A

Data of Engine Rotor Failures in U.S. Commercial Aviation for 1984. Compiled from the Federal Aviation Administration Service Difficulty Reports.

Data Compilation Key

Component Code:
- F - Fan
- C - Compressor
- T - Turbine

Fragment Type Code:
- D - Disk
- R - Rim
- B - Blade
- S - Seal
- N - None

Cause Code:
- 1 - Design and Life Prediction Problems
- 2 - Secondary Causes
- 3 - Foreign Object Damage
- 4 - Quality Control
- 5 - Operational
- 6 - Assembly and Inspection Error
- 7 - Unknown

Containment Condition Code:
- C - Contained
- NC - Not Contained
- N - No Fragments Generated

Flight Condition Code:
- 1 - Insp/Maint
- 2 - Taxi/Grnd Hdl
- 3 - Takeoff
- 4 - Climb
- 5 - Cruise
- 6 - Descent
- 7 - Approach
- 8 - Landing
- 9 - Hovering
- 10 - Unknown

CHARACTERISTICS OF ROTOR FAILURES - 1984

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
103084067	PSA	BAE146	ALF502	T	B	1	C	4
011284090	EAL	DC10	CF6	T	B	2	C	4
091484024	WRL	DC10	CF6	T	B	7	C	4
080784045	UAL	DC10	CF6	C	B	3	C	3
042484187	WAL	DC10	CF6 UNK	C	B	1	NC	3
111384057	AAL	DC10	CF6	T	B	7	C	4
081484087	AAL	DC10	CF6	T	B	1	C	4
012684114	PAA	DC10	CF6	C	B	7	C	5
050984079	CAL	DC10	CF6	F	B	3	C	3
092584028	AAL	DC10	CF6	T	B	2	C	4
090484117	WRL	DC10	CF6	F	N	3	N	3
042484200	UAL	DC10	CF6	F	N	3	N	4
042484198	EAL	DC10	CF6	F	N	3	N	3
061484036	PAA	DC10	CF6	C	N	7	N	4
020784203	PAA	DC10	CF6	C	N	3	N	2
110884043	UAL	DC10	CF6	T	N	2	N	3
052284165	AAL	DC10	CF6	T	N	2	N	5
042484195	UAC	DC8	CFM562	C	N	3	N	3
020684055	OXE	F27	DART511	T	N	7	N	3
041884031	BHA	STC24	DART542	T	N	2	N	7
052984133	WRT	STC24	DART542	T	N	2	N	1
102584003	ASR	WEST.30	GEM510	T	N	2	N	9
102584004	ASR	WEST.30	GEM10	T	N	2	N	1
041084004	AMT	B707	JT3D	F	B	7	C	5
071784092	AMT	B707	JT3D	F	N	3	N	3
031584106	RAY	DC8	JT3D	T	N	7	N	5
062684082	EAL	B727	JT3D	C	B	7	C	3
091184052	PEX	B727	JT8D No.3	T	B	2	NC	3
051584131	EAL	B727	JT8D	C	B	7	C	3
110684020	DAL	B727	JT8D No.1	T	B	7	NC	3
062984033	NWA	B727	JT8D	T	B	1	C	4
041884025	EAL	B727	JT8D	T	B	7	C	4
041184105	DAL	B727	JT8D	T	B	2	C	4
060584136	OZA	DC9	JT8D	T	B	1	C	4
070384096	REP	DC9	JT8D	T	B	1	C	3
062184023	REP	B727	JT8D	T	B	7	C	4
032884093	EAL	B727	JT8D	C	B	2	C	8
121084050	HAL	DC9	JT8D	C	B	1	C	5
041084032	HAL	DC9	JT8D	C	B	7	C	3
041084031	HAL	DC9	JT8D	C	B	7	C	4
121884064	HAL	DC9	JT8D	V	B	7	C	5
0313B4066	HAL	DC9	JT8D	C	B	7	C	3
031384067	HAL	DC9	JT8D	C	B	1	C	3
050184150	HAL	DC9	JT8D	T	B	1	C	3

CHARATERISTICS OF ROTOR FAILURES - 1984

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC		COMPONENT	FLIGHT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
030684138	AAL	DC9	JT8D		C	B	7	C	4
061984102	ACL	DC9	JT8D		C	B	3	C	1
102484011	TWA	DC9	JT8D		C	B	1	C	4
052284155	REP	DC9	JT8D		C	B	7	C	3
050984078	ACL	DC9	JT8D		T	B	1	C	3
022884128	EAL	DC9	JT8D	UNK	C	B	7	NC	3
121784057	DAL	DC9	JT8D	UNK	C	B	1	NC	4
032284121	ONE	B727	JT8D		C	B	3	C	4
032884094	EAL	B727	JT8D	No.1	C	B	2	NC	3
081484089	NWA	B727	JT8D		T	B	1	C	4
100283030	EAL	DC9	JT8D		T	B	1	C	3
052284159	REP	DC9	JT8D		C	B	7	C	3
121884075	EAL	DC9	JT8D		T	B	1	C	4
040484075	REP	DC9	JT8D		T	B	1	C	3
032284112	REP	DC9	JT8D		T	B	1	C	3
020284037	EAL	DC9	JT8D		T	B	2	C	4
111984077	USA	DC9	JT8D		T	B	7	C	7
100484050	REP	DC9	JT8D		T	B	2	C	5
100383042	REP	DC9	JT8D		T	B	7	C	4
070384126	REP	DC9	JT8D		T	B	1	C	4
021084016	AKB	DC9	JT8D		T	B	7	C	3
062684086	OZA	DC9	JT8D		T	B	1	C	4
090484118	USA	DC9	JT8D	UNK	C	B	1	NC	3
022884124	USA	DC9	JT8D		T	B	1	C	4
051584139	NW	B727	JT8D		T	B	1	C	4
091884056	UAL	B727	JT8D		T	B	1	C	3
012480467	USA	DC9	JT8D		T	R	1	C	4
090484115	TBA	B727	JT8D		T	B	7	C	4
909484072	MID	DC9	JT8D		T	B	7	C	3
082884127	MID	DC9	JT8D	No.3	T	D	7	NC	3
102484007	BNF	B727	JT8D		T	B	7	C	3
091884047	REP	DC9	JT8D		T	B	7	C	4
121084045	TWA	B727	JT8D		C	B	2	C	5
020784202	SWA	B737	JT8D		T	B	2	C	4
071184010	OZA	DC9	JT8D		T	B	7	C	3
051584138	SWA	B737	JT8D		T	B	2	C	4
060784067	OZA	DC9	JT8D		T	B	1	C	4
062684126	UAL	B727	JT8D		T	B	1	C	2
042484194	EAL	DC9	JT8D	No.2	T	D	7	NC	4
120584086	CAL	DC9	JT8D		T	B	1	C	3
120384021	CAL	DC9	JT8D		T	B	7	C	4
032884128	TWA	B727	JT8D		T	B	7	C	4
012484069	TWA	B727	JT8D		T	B	7	C	4
082184158	AKB	DC9	JT8D		C	N	7	N	1
112684087	DAL	B727	JT8D		C	N	2	N	4

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SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
091884055	FAL	B737	JT8D	T	N	2	N	3
121984058	EAL	DC9	JT8D	T	N	2	N	4
100484045	REP	B727	JT8D	C	N	7	N	5
071184003	EAL	DC9	JT8D	F	N	3	N	5
011284098	REP	B727	JT8D	T	N	2	N	3
032884089	USA	B727	JT8D	T	N	2	N	3
021584007	HAL	DC9	JT8D	C	N	7	N	6
080384017	AKB	DC9	JT8D	T	N	7	N	4
121084042	ACL	DC9	JT8D	C	N	7	N	3
061984110	ACL	DC9	JT8D	C	N	7	N	5
100484046	TWA	DC9	JT8D	C	N	3	N	3
020784208	UAL	B737	JT8D	F	N	3	N	7
120384051	ACL	B737	JT8D	C	N	3	N	1
041884023	EAL	B727	JT8D	T	N	7	N	4
022284151	REP	DC9	JT8D	T	N	2	N	5
122484056	REP	DC9	JT8D	T	N	2	N	5
091884045	RAY	DC9	JT8D	T	N	7	N	4
012684106	EAL	B727	JT8D	T	N	7	N	5
061984115	NIA	B727	JT8D	T	N	7	N	3
071184005	REP	DC9	JT8D	T	N	7	N	1
031384068	OZA	DC9	JT8D	F	N	3	N	3
050184136	ONE	B727	JT8D	C	N	1	N	1
051584140	NWA	B727	JT8D	F	N	3	N	4
072484004	AER	B727	JT8D	C	N	3	N	5
100984024	CAL	DC9	JT8D	C	N	1	N	4
110684050	REP	DC9	JT8D	C	N	2	N	3
111984075	PAI	B737	JT8D	T	N	7	N	3
020284026	SWA	B737	JT8D	F	N	3	N	4
042484192	WAL	B737	JT8D	F	N	3	N	4
120384020	PEX	B727	JT8D	C	N	3	N	3
060584142	PEX	B727	JT8D	C	N	3	N	4
011284104	SWA	B737	JT8D	C	N	3	N	6
050284002	PEX	B727	JT8D	C	N	3	N	3
050184134	PEX	B727	JT8D	C	N	3	N	3
121084043	AWX	B737	JT8D	C	N	2	N	1
073184005	NYA	DC9	JT8D	T	N	7	N	4
051584145	NYA	DC9	JT8D	T	N	7	N	4
050884096	EAL	DC9	JT8D	F	N	3	N	4
122784013	UAL	B727	JT8D	F	N	3	N	3
122484060	UAL	B727	JT8D	C	N	7	N	4
011984103	EAL	B727	JT8D	T	N	7	N	3
061484939	EAL	DC9	JT8D	T	N	7	N	5
031384062	NWA	DC10	JT9D	C	B	2	C	4
091884046	NWA	DC10	JT9D	T	B	2	C	3
111484117	NWA	DC10	JT9D	T	B	7	C	4
110684051	NWA	DC10	JT9D	T	B	7	C	4

CHARACTERISTICS OF ROTOR FAILURES - 1984

SDR NO.	SUBMITTER	AIRCARFT	ENG/LOC	COMPONENT	FLIGHT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
071184004	NWA	DC10	JT9D	T	B	7	C	4
102484013	NWA	B747	JT9D	T	B	1	C	4
041884024	NWA	B747	JT9D	T	B	7	C	4
121884077	TWA	B747	JT9D	T	B	1	C	4
120484118	TWA	B747	JT9D	T	B	7	C	3
092684024	FTL	B747	JT9D	T	B	7	C	4
011284094	NWA	B747	JT9D	C	B	7	C	4
011284093	NWA	B747	JT9D	C	B	7	C	5
092584073	NWA	B747	JT9D	C	S	7	C	4
102484009	NWA	B747	JI9D UNK	T	S	2	NC	4
061984127	FTL	B747	JT9D	T	B	7	C	4
032884096	FTL	B747	JT9D UNK	T	B	2	NC	5
041084029	AAL	B747	JT9D No.2	F	B	7	NC	3
120584085	UAC	B747	JT9D No.4	T	D	7	NC	3
011284108	AAL	B747	JT9D	F	N	3	N	3
110684019	UAL	B747	JT9D	F	N	3	N	3
080384021	UAL	B747	JT9D	C	N	3	N	6
101784042	PAA	B747	JT9D	F	N	3	N	4
011284102	PAA	B747	JT9D	C	N	7	N	4
032884095	PAA	B747	JT9D	T	N	2	N	3
050884103	TWA	B747	JT9D	F	N	3	N	8
012484062	NWA	B747	JT9D	F	N	2	N	4
103084064	FTL	B747	JT9D	F	N	3	N	1
050284033	MTR	DHC6	PT6A	T	B	7	C	3
021084001	BRI	B99	PT6A RH	C	B	2	C	7
080884074	RIO	DHC6	PT6A	C	B	3	C	3
032084032	MTR	DHC6	PT6A	C	S	7	C	3
030984026	MTR	DHC6	PT6A	C	B	7	C	6
112784024	RAY	EMB110	PT6A	T	B	1	C	4
022184003	IMP	EMB110	PT6A	T	B	7	C	3
041284118	IMP	EMB110	PT6A	T	B	7	C	1
121884070	PCA	SD330	PT6A	T	B	7	C	5
121084040	RMA	DHC7	PT6A	T	B	7	C	2
010584005	HAL	DHC7	PT6A	T	B	7	C	5
061984124	RMA	DHC7	PT6A	T	B	7	C	4
101184023	HAL	DHC7	PT6A	T	B	7	C	5
022484011	BRI	B99	PT6A UNK	T	B	7	NC	3
030184055	MTR	DHC6	PT6A	C	N	3	N	2
030184052	SW99	659	PT6A	T	B	7	NC	10
111848028	AIA	EMB110	PT6A	C	N	3	N	5
041984022	CIC	G73	PT6A	T	N	7	N	4
112384005	AWA	B99	PT6A	T	N	7	N	5
010484008	MVA	SD330	PT6A	T	N	7	N	3
031584109	ERA	DHC7	PT6A	T	N	7	N	4
102484015	PAA	L1011	R8211	T	B	7	C	5
011284116	EAL	L1011	RB211	C	N	3	N	3

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SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
112084027	EAL	L1011	RB211	C	N	3	N	7
103184024	EAL	L1011	RB211	F	N	3	N	6
041184102	USA	BAC111	SPEY	C	B	7	C	4
050884097	FLE	BAC111	SPEY	T	B	7	C	4
102984068	EMP	F28	SPEY	C	B	7	C	3
020784210	USA	BAC111	SPEY	C	N	3	N	3
082884121	PAI	F28	SPEY	C	N	7	N	3
111684042	AMW	SA226	TPE331 RH	T	D	7	NC	3
110584116	EMP	SA226	TPE331	T	B	7	C	4
083184011	EMP	SA226	TPE331	T	B	7	C	4
011084082	SWI	SA227	TPE331	C	N	3	N	5
052984126	WRN	CL44	TYNF	C	N	3	N	4
050284040	WRN	CL44	TYNE	C	N	3	N	3
020284028	AEI	CL44	TYNE	T	N	2	N	5
082784010	SW62	B206L1	250C28	T	D	7	NC	5
092784005	WP07	B206B	250C20	T	D	7	NC	5
020784211	FLA	188C	501D13	C	N	3	N	7
050184146	CRA	STCAPJC	501D13	C	N	3	N	4
060584145	CRA	STCAPJC	501D13	C	N	3	N	4
011284113	CRA	STCAPJC	501D13	C	N	3	N	7
011984119	REP	STCAPJC	501D13	T	N	7	N	3
103084058	TIA	382G	501D13	C	N	3	N	4
100384018	SRA	382G	501D13	T	N	2	N	5
100984006	SRA	382G	501D13	T	N	7	N	5
082184156	REP	STCAPJC	501D13	C	N	3	N	3